Oniscus asellus with especial reference to the History of the Chromatin.

Jonathan Taylor Rorer: A Definitive Determination of the Orbit of Comet 1898 χ—Brooks.

Thomas Maynard Taylor: I. The Atomic Weight of Tungsten. II. On the Ammonium Tungstates.

Caroline Burling Thompson: Zygeupolia Litoralis: A New Herteronemertean.

Roxana Hayward Vivian: The Poles of a Right Line with Respect to a Curve of Order n.

CLARK UNIVERSITY.

Clemence J. France: Psychology of Gambling.

Samuel B. Haslett: A Plan and Rationale of Sunday School Work.

James Edmund Ives: Contributions to the Study of the Induction Coil.

Herbert G. Keppel: The Cubic 3-spread Ruled with Planes in 4-fold space.

Melanchthon F. Libby: Influence of the Idea of Æsthetic Proportion on the Ethics of Shaftesbury.

Charles H. Sears: Studies in Rhythm.

John N. Van der Vries: On the Multiple Points of Twisted Curves.

UNIVERSITY OF VIRGINIA.

Dr. Wm. A. Lambeth: Geology of the Monticello Area.

C. J. Moore: On the Products of Interaction between the Aliphatic Amines with certain Metallic Salts.

Herbert R. Morgan: The Orbit of Enceladus.

L. D. Skeen: Bacterial Flora of Charlottesville Reservoir Water.

UNIVERSITY OF WISCONSIN.

Charles Kenneth Leith: Rock Cleavage.

Charlotte Elvira Pengra: On Functions connected with Special Riemann Surfaces, in Particular those for which $p = 3$, 4 and 5.

Herman Schlundt: On the Dielectric Constants of Pure Solvents.

UNIVERSITY OF CALIFORNIA.

Russell Tracy Crawford: Determination of the Constant of Refraction from Observations made with the Repsold Meridian Circle of the Lick Observatory.

Frank Elmore Ross: Differential Equations Belonging to a Ternary Linearoid Group.

BRYN MAWR COLLEGE.

Mary Bidwell Breed: The Polybasic Acids of Mesitylene.

Elizabeth Rebecca Laird: The Absorption Spectrum of Chlorine.

BROWN UNIVERSITY.

Leonard Worcester Willians: The Anatomy of the Common Squid.

COLUMBIAN UNIVERSITY.

William Mather Lamson: Iron and Steel Domes.

LELAND STANFORD JUNIOR UNIVERSITY.

John Flesher Newson: A Geologic and Topographic Section across Southern Indiana, from the Ohio River at Hanover to the Wabash River at Vincennes, with a discussion of the General Distribution and Character of the Knobstone Group in the State of Indiana.

VANDERBILT UNIVERSITY.

Warren Henry Hollinshead: Some Points in Analytical Chemistry.

UNIVERSITY OF NEBRASKA.

Wilbur Clinton Knight: The Artesian Basins, Oil Fields and Mining Districts in Wyoming.

NEW YORK UNIVERSITY.

John A. Mandel: Glycuronic or Glucoronic Acid.

WASHINGTON UNIVERSITY.

Herbert J. Webber: Spermatogenesis and Fecundation of Zamia.

---

*A BASIS OF SCIENTIFIC THOUGHT.**

LÉMERY in his *Cours de Chemie* (1675) was the first to separate that branch of science termed chemistry into organic and inorganic. The latter embraced those bodies found in the mineral world and those produced by means of such substances. Berzelius, recognizing that organic bodies contained carbon, maintained that they came about through the influence of a particular force—*vis vitalis*. In 1828, however, Wöhler synthetically prepared, from strictly inorganic materials in the laboratory, urea, the eventual product of animal metabolism. This discovery was followed by the synthesis of numerous other bodies hitherto thought to be possible of preparation only through the mysterious life-force.

Although the fundamental laws underlying these divisions of chemistry are the same, yet for pedagogic convenience this classification is adhered to by many; oth-

* Read at the April meeting of the N. C. Section of the American Chemical Society.

ers even diversify at greater length and we have physical chemistry, technological, analytical, agricultural and physiological chemistry. Chemical laws prevail and are the same, it matters not how one classifies his facts.

By mathematics through ages we have sought expression, whether by definite exact numbers, equations or indeterminates. It is the language of physics, making possible the expression of the invention of means for measuring force and calculating its effect upon matter. Joule, Helmholtz, Robert Mayer and Maxwell in their refined discoveries in mechanics touched chemistry, for the explanations of the phenomena of dissociation, solution, vapor pressure, osmotic pressure, etc., as developed by Arrhenius, Van't Hoff and Nernst, and taught by Ostwald, could never have gained currency save through the invention of a mode of quantitative expression by the former *savants*. J. B. Richter over a hundred years ago said that chemistry was a branch of mathematics. In fact, recently Lord Kelvin said 'Nothing can be clearly understood until we can express it in figures.'

It has only been within the past three-tenths of the present century that the barriers between physics and chemistry have been completely removed. This came about through the necessity of applying more closely certain laws of physics for the explanation of chemical facts, as, for example, electrolytic conductivity, heat of reaction and so on, and reciprocally by conversion of chemical force into electrical energy, heat, phosphorescent light, etc., and measuring the same. Mathematics has served as the medium of quantitatively determining these changes—in short, physical chemistry.

Geology may be termed the chemistry and physics of the earth's crust, more particularly applied to the inanimate portion of the world, although full cognizance is taken of alterations of the shell by animals. Latterly geology and biology, the chemistry and physics of animal life, may be said to merge. Only recently chemistry and biology have been more firmly welded into a unit by the interesting work of Bredig and Müller von Berneck on 'Inorganic Ferments,' in which was demonstrated that certain life processes, hitherto regarded as possible only through the intervention of bacilli, could be carried out by means of an active chemical. This step is far in advance of even Büchner's enzyme fermentation. Attention has been called by the sensational press to the incomplete, but fruitful and promising, researches of Loeb and E. B. Wilson on parthenogenesis or chemical fertilization.

Cognizant of the persistent outcropping of favorable evidence for Darwin's evolution, we observe a unity of purpose in animal growth. Astronomy is the chemistry and physics of celestial bodies, and our knowledge of them is based upon observations dependent upon mathematical considerations. By the term mathematics here used of course must be meant simply a method by which the senses judge.

Accepting, therefore, the articulated relation among the various utilitarian divisions of science, we may develop our theme along the lines of those teachings of which we feel best qualified to write, namely, physics and chemistry, and regard all science as these two differently applied, either as to method of application, or class to which we would direct the application. We are perfectly aware of valid arguments that may be put forward strenuously against such a conception, yet feel that we shall be reduced to the study of a unity, as we must eventually express our knowledge of all science, qualitative and quantitative, mathematically.

Despite this unifying tendency to which we would call attention, chemists persist in discovering new elements, as argon, helium,

neon, krypton, radium, polonium, etc., and seem to have *facts* in direct opposition to our ideas. Over a century ago the same Richter noted resemblances of what chemists now term elements. Lavoisier by chemical and physical means proved the law of conservation of matter. Then Dalton ascribed weights to these elements composing matter, from which came our satisfactory atomic theory. None of these, as well as Joule's masterful proof of the conservation of energy, was possible without a medium of expression, namely mathematics, whereby the necessary comparison of weights and other measurements could be made. The triads of Döbereiner and Dumas, and Newlands' octaves foreshadowed a periodicity in atomic properties as later clearly and definitely set forth by Mendeléeff and Lothar Meyer. This periodic law, so long accepted, has had shadows cast upon its universality by the failure of scientists so far to satisfactorily arrange the new elements noted (and several old ones) in accord with it. Naturally we lend ourselves to the thought that this is due to our insufficient knowledge of these novel and striking members of the chemical family.

Prout may not have been so far wrong in conception when he asserted that all the elements were compounded of hydrogen, then known to have the lowest of all atomic weights. Stas's classical researches and redeterminations of the atomic weights and Morley's accurate proof of the mass relations of hydrogen and oxygen prevent absolutely the acceptance of the fact of the statement, but the germ of thought bears fruit. The idea is still prevalent, and Crookes has termed that initial, universal substance of which all else is composed, *protyle*. In fact, J. J. Thomson has only recently, in very wonderful researches on electric discharges in gases, been able ingeniously to demonstrate, by mathematical interpretation of the experimental results, that the atom is made up of a number of smaller bodies, which he terms *corpuscles*.

Thus we are brought almost face to face with the most ancient alchemical teachings. Within recent years, Hartley, thoroughly orthodox, has written that "one element in a group differs in its properties from another not because it consists of another kind of matter, but because the quantity of matter in an atom is different." While we are not inclined to give over-serious consideration to Fittica's recent assertion that he has actually transmuted phosphorus into arsenic under one set of conditions and into antimony under another, doubtless later transmutation will become an experimental fact; not that all our base metal will be converted into a precious one, but we shall secure more refined methods and further decompose our present elements; or the increased number of elements, yearly augmented, shall give us a more perfect periodicity, demonstrating the relationship of the elements and their unity without requiring the actual experimental proof. The speculative hylozoists may thus have foretold events.

We have other experimental evidence pointing in the direction indicated. Some of our chemistries, not so long ago, dogmatically taught that hydrogen was the lightest known gas and impossible of liquefaction; or if it could be solidified, it would be metallic in character. Dewar, Olzewsky and Wroblewsky have secured that gas as a limpid liquid by intense refrigeration in vacuum-jacketed apparatus. And but recently the first named in classical researches reduced the temperature of liquid hydrogen to within eighteen degrees of the absolute zero (— 255° C.) and obtained white, crystalline, solid hydrogen. These researches with extreme cold and Moissan working at from three to four thousand degrees give us the widest ranges of temperature. The latter has already secured many elements hitherto regarded as non-volatile in a gas-

eous condition. Like Dewar's work at the low temperatures, it appears that a refinement of skill will secure all elements in a gaseous condition. Thus all matter, that is, elemental, may exist in the three physical states.

In the domain of physics, observation of the marvelous effects of the Röntgen rays, Becquerel rays, the characteristic property of certain old and some recently discovered elements, as barium, thorium, radium and polonium, show new things undreamt of. We cannot say that these discoveries, praise-deserving and wonder-creating as they are, will give us final proof of the truth of our premise as put forth, yet they do point in that direction.

All forms of energy are interchangeable, hence we have but one force, whether it exhibit itself as heat, electrical energy, chemical force, or what not. These new rays, active and specific in their demonstration, are but altered forms of the *one* force. Why not therefore a *one matter*? Having reached that point we may con within reason Ostwald's dictum, that all is force, there is no such thing as matter. We may well conclude by repeating the query of the elder Büchner, that *aberwitzig* youth: "Is it a duty to believe things that can not be proven?"

CHARLES BASKERVILLE.

---

*FORMATIVE MUSEUM PERIOD.**

SCIENTIFIC activity developed more slowly and was less encouraged in New York in the earlier years of this century than in its neighboring rivals Boston and Philadelphia The expression of a mercantile, or more harshly described as that of a money-making city was early acquired, and baffled or obscured the spirit of scientific research. In a measure this suggestion, applied to the miscellaneous avenues of enterprise and the accumulation of wealth, was sensibly deceptive. It would be quite impossible to stifle the incentives to the study of nature in a population of nearly one million people, and the limited consideration given to physical, chemical and geological science in the colleges, high-schools and seminaries, which aroused unfailingly increased interest in the objects of nature, led to their collection, and stimulated local societies in their study and record.

An examination of the decade immediately prior to the establishment of the American Museum of Natural History, and by implication a reference to the conditions somewhat earlier, show us the formative stages shaping public needs for its appearance and public appreciation of its value.

Philanthropic and social designs, historical research, theological learning, medical study and literary invention were significant in the more intellectual life of New York City from 1830 to the date of the foundation of the Museum in 1870; the active participation in education of three colleges, a normal school for women, two medical schools, and numerous lesser centers of learning, including the invaluable services of the Cooper Institute with two seminaries devoted to religious instruction, were distinctive evidence that New York was not oblivious to the claim of knowledge.* But science in its purer forms and especially the study of nature in its animal and vegetable life, received scant recognition in the curriculæ of instruction. Two societies, the New York Academy of Sciences, later (1876) the Lyceum of Natural History, and the Torrey Botanical Club (1870), were the guardians and shrines of the scientific life of the city, and collected in a compact coterie the separated enthusiasts

* Columbia University (King's College) dates from the last century (1754); the New York University was opened 1831; the College of the City of New York (Free Academy) in 1849; The Normal College in 1855; Union Theological Seminary in 1836; General in 1817.